A Soil Erosion and Sediment Control Planning System for Managed Forest Land:

A Case Study at Shomar Creek, Queen Charlotte Islands

Land Management
Report NUMBER 69

ISSN 0702-9861

FEBRUARY 1992

BC
Ministry of Forests

FISH/FORESTRY INTERACTION PROGRAM

This study was undertaken as part of the Fish/Forestry Interaction Program (FFIP), a multidisciplinary research study initiated in 1981. The program was started following a series of major winter storms in 1978 that triggered landslides over much of the Queen Charlotte Islands' forest land base. Originating on steep slopes, many slides deposited tonnes of debris in streams and on valley flats. The events raised private and public concerns over logging practices on the Islands and prompted the establishment of the 5-year program. Overall objectives of FFIP were:

- to study the extent and severity of mass wasting and to assess its impacts on fish habitat and forest sites;
- to investigate the feasibility of rehabilitating stream and forest sites damaged by landslides;
- to assess alternative silvicultural treatments for maintaining and improving slope stability; and
- to investigate the feasibility and success of using alternative logging methods, including skylines and helicopters, and by logging planning to reduce logging-related failures.

The program is jointly funded by direct appropriations from the Canada Department of Fisheries and Oceans, the B.C. Ministry of Forests (Forest Science Research Branch), and the B.C. Ministry of Environment (Fisheries Branch). Participating agencies include Forestry Canada (Pacific Forestry Centre), and the Forest Engineering Research Institute of Canada (FERIC), Vancouver, B.C.

Program results are published through the B.C. Ministry of Forests, Land Management Report series, as well as in papers presented at symposiums, conferences, and through technical journals.

For information about the program contact Ministry of Forests, Forest Science Research Branch, 31 Bastion Square, Victoria, B.C. V8W 3E7.

92-05149/

A Soil Erosion and Sediment Control Planning System for Managed Forest Land:

A Case Study at Shomar Creek, Queen Charlotte Islands

by
W.W. Carr and I. Wright

Terrosol
P.O. Box 2092
Vancouver, B.C.
V6B 3T2

February 1992

BC
Ministry of Forests

Canadian Cataloguing in Publication Data

Carr, William W., 1952-
A soil erosion and sediment control planning system for managed forest land

(Land management report, ISSN 0702-9861 ; no. 69)

Includes bibliographical references: p.
ISBN 0-7718-9130-X

1. Soil erosion - British Columbia - Queen Charlotte Islands. 2. Sediment control - British Columbia - Queen Charlotte Islands. 3. Logging - Environmental aspects - British Columbia - Queen Charlotte Islands. 4. Watershed management - British Columbia - Queen Charlotte Islands. I. Wright, I. II. British Columbia. Ministry of Forests. III. Title. IV. Series.

SD387.E58C37 1992 634.9'8 C91-092344-2

© 1992 Province of British Columbia
Published by the
Forest Science Research Branch
Ministry of Forests
31 Bastion Square
Victoria, B.C. V8W 3E7

Copies of this and other Ministry of Forests titles are available from Crown Publications Inc., 546 Yates Street, Victoria, B.C. V8W 1K8.

ACKNOWLEDGEMENTS

Funding for this project was provided by a grant from the Fish/Forestry Interaction Program – Phase II, under the supervision of Vince Poulin, with the co-operation of the Sandspit Division of Fletcher Challenge Ltd. Their initiative and support were invaluable to the completion of this planning system. Gary Lawson of Fletcher Challenge Ltd. provided valuable field support and enthusiasm for the project, for which the authors are extremely grateful. We are also indebted to Steve Chatwin of the B.C. Ministry of Forests, Forest Science Research Branch, for his efforts in promoting this planning system, and providing funding for its publication.

ABSTRACT

Public and professional awareness of the impacts of forest resource development on fish and watershed values has increased dramatically over the past decade. Proper planning and implementation of soil erosion and sediment control procedures must be an integral part of forest resource management. In co-operation with the Fish/Forestry Interaction Program, Ministry of Forests' Forest Science Research Branch, and Fletcher Challenge Canada Ltd., Terrasol has developed a formal approach to soil erosion and sediment control planning for managed forest watersheds in British Columbia. The approach presented in this paper has been implemented on an operational basis in British Columbia, and moves sediment and erosion control operations from being post-damage "band-aid" treatments into an active, cost-effective mitigation program.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

ABSTRACT iii

1 INTRODUCTION 1

1.1 Rationale 1
1.2 Objectives 2
1.3 Study Area 2

2 SOIL EROSION AND SEDIMENT CONTROL PLAN STRUCTURE 4

3 PLAN COMPONENTS 4

3.1 Rehabilitation Objectives 4
3.1.1 Objectives of the Shomar Creek plan 5

3.2 Erosion Inventory 5
3.2.1 Shomar Creek inventory of problem sites 5

3.3 Priority Assignment 7
3.3.1 Priority criteria for Shomar Creek 8

3.4 Treatment Options 9
3.4.1 Recommended treatments for Shomar Creek 10

3.5 Costs and Scheduling 10
3.5.1 Scheduling and costing for Shomar Creek 11

4 SUMMARY 12

APPENDIX 1 Soil erosion and sediment control plan: Shomar Creek, Queen Charlotte Islands, TFL 42, Fletcher Challenge Ltd. 13

LITERATURE CITED 24

TABLES

1 Shomar Creek disturbance inventory 6

2 Shomar Creek rehab and priority summary 9

FIGURES

1 Location of Shomar Creek study area 3

2 Example from the Shomar Creek rehab mylar 6

3 System for assigning priority classes in the Shomar Creek study area 7

1 INTRODUCTION

One of the principal objectives of the Fish/ Forestry Interaction Program (FFIP) – Phase II is to facilitate the transfer of information from Phase I to operational staff within the forest industry and resource agencies. This information transfer, particularly when carried out through co-operative projects, will provide a solid basis for improved forest harvesting operations in areas sensitive to erosion processes.

Hillslope rehabilitation, using a range of erosion and sediment control techniques, is an important part of improved forest harvesting practices. Carr (1985), in a review of techniques suitable for use on disturbed slopes in the Queen Charlotte Islands, concluded that these techniques must be incorporated into the forest management planning process to be of maximum benefit.

At present, soil erosion and sediment control activities in forest watersheds throughout British Columbia are generally undertaken on an ad hoc basis or as required by some other resource agency. As awareness of fish/forestry problems increases, however, programs to minimize the effects of soil erosion and sedimentation are being proposed. These programs require a structured approach to soil erosion and sediment control planning, to ensure operational efforts are focussed and cost effective.

This project provides such a planning approach. As part of FFIP – Phase II, and in co-operation with Fletcher Challenge Ltd., a systematic planning approach is presented here in both general and operational terms, showing the steps required by a forest manager to satisfy environmental concerns about forest soil conservation and resource planning.

1.1 Rationale

Public and professional awareness of how forest resource development can potentially harm fishery and watershed values has increased dramatically over the past few years. The recently adopted *Coastal Fishery Forestry Guidelines* (1987) have increased the pressure on forest managers to minimize these effects on both existing and future forestry operations. Watershed research projects such as FFIP and the Carnation Creek study have not only documented the potential detrimental processes that may occur in managed forest watersheds, they have also shown that the opportunity exists to prevent or alleviate resource damage.

Road development and timber harvesting operations are principal causes of soil degradation. Such degradation may lead to accelerated surface erosion and mass wasting, two processes that can adversely affect fishery values, water quality, and future site productivity. Fortunately, many of the erosion and water quality problems associated with forest resource development can be alleviated, if not prevented, through proper planning and implementation of soil erosion and sediment control procedures. However, such planning must be an integral part of forest resource management, and there must be a commitment to carry the plan through to final implementation. This type of approach moves sediment and erosion control from post-damage, "band-aid" treatments into an active, cost-effective, mitigative program. The results from the Redwood Park Restoration Program of the U.S. National Park Service in California have shown the success achievable with such a program.

An erosion and sediment control plan, often referred to as a watershed "rehab" plan, must be compatible with the management objectives of the area. Current and future road development and timber harvesting plans, water quality, recreation potential, and fishery values are among those factors that provide the focus of the plan. An inventory of active and potential problem areas is needed, in conjunction with criteria for ranking future activities. Management solutions and treatment options should be developed for each problem area, along with an implementation schedule. The schedule should promote an orderly and logical undertaking of rehab treatment options based on available funding.

This type of soil erosion and sediment control planning system can help the land manager minimize the potential negative effects of timber harvesting on other resource values in sensitive watersheds.

1.2 Objectives

This report has two objectives. The first is to explain the approach and procedures for developing a comprehensive, operational soil erosion and sediment control plan (rehabilitation or "rehab" plan) for managed forest watersheds in British Columbia. The second objective is to field test the planning system at an operational scale. The documentation of the planning process, combined with an operational plan, should provide a template from which this concept can be expanded to other managed forest watersheds in British Columbia.

The components of a rehab plan should be developed in response to management concerns within a watershed. As such, they may be simple or very complex, and the structure of the plan must be flexible to meet a range of management needs. In the demonstration watershed used for this report, Shomar Creek, the management concerns were directed solely at the impacts of timber harvesting development on slope stability and downstream fishery values. In other watersheds, concerns such as recreational value, visual impact, and community water supply can be incorporated into the planning system.

The main body of this report describes soil erosion and sediment control planning in general and as applied to Shomar Creek. Details of the entire operational plan are presented in Appendix 1.

1.3 Study Area

The Shomar Creek watershed was selected as the demonstration drainage for the planning system in response to the commitment of the Sandspit Division of Fletcher Challenge to sediment and erosion control. With a logging history from the early 1960's and plans for continued forest management, Shomar Creek presents a cross-section of sediment and erosion control concerns commonly encountered in managed forest watersheds. Fletcher Challenge Ltd. has been actively involved with erosion control projects since the late 1970's and is committed to the implementation of this plan. Another FFIP study will evaluate the success of the implementation measures over a 5-year period.

The Shomar Creek watershed is centrally located along the northern edge of Moresby Island, part of the Queen Charlotte Islands (Figure 1). The creek enters the Deena River, a major salmon spawning and rearing river, approximately 6 km from the South Bay estuary. Shomar Creek is a class IV stream with no fish population because of a major blockage at the old Spur 105 crossing. However, the creek is important to downstream fish habitat because of its relatively high flow capacity and substantial sediment delivery potential.

Encompassing approximately 900 ha of good and medium site forest land, the Shomar Creek watershed is an important area in TFL 42. As part of the Coastal Western Hemlock – wet hypermaritime (CWH–wh1) biogeoclimatic zone, its old-growth stands are composed of western redcedar, western hemlock, and Sitka spruce. Second-growth stands are predominantly Sitka spruce and western hemlock. This steep-sided drainage basin is a complex of terrain units. The lower portions of the watershed are mainly glaciofluvial and morainal materials; the middle and upper slopes are dominated by morainal blankets or colluvial veneer and exhibit substantial bedrock influence. Often exceeding 100% in steepness, the upper slopes are characterized by steep, unstable gully systems.

Harvesting activity began in the watershed during the mid-1960's. Initial operations concentrated on the flatter areas and the west side of the basin accessed by the Spur 105 road network. The more recent and current logging activities are on the east slopes and along the Spur 104 system. Future plans include continued old-growth logging and the reopening of the Spur 105 road complex for stand management access.

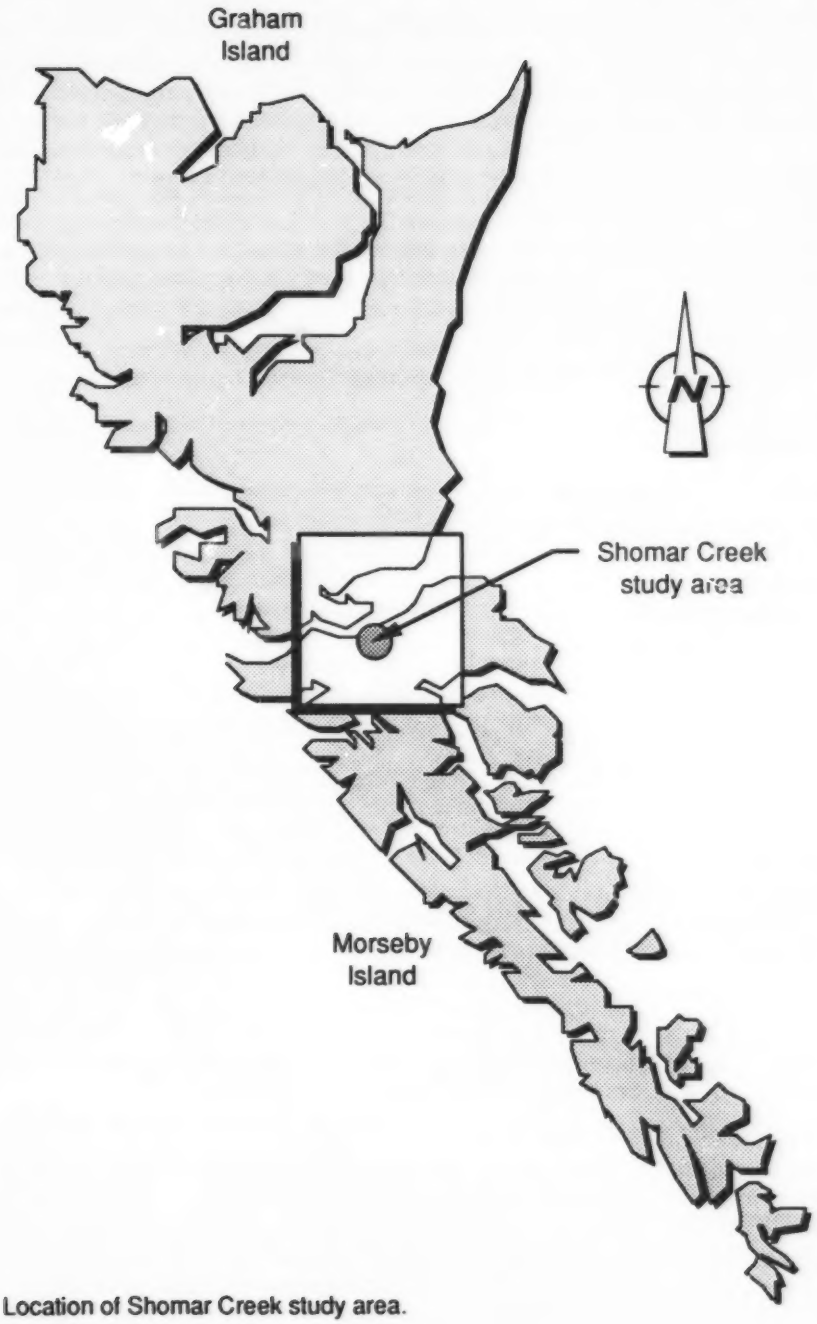

FIGURE 1. Location of Shomar Creek study area.

2 SOIL EROSION AND SEDIMENT CONTROL PLAN STRUCTURE

A soil erosion and sediment control plan should be developed under the direction of a specialist in the area, in co-operation with the forest licensee and appropriate resource agencies. Public participation in the planning process can also be included if it is warranted by resource concerns. The plan must also be flexible enough to address the range of conditions and concerns that may occur in any given watershed.

Small, informal soil erosion and sediment control plans for some forest road development projects are not uncommon in British Columbia forestry and require little time to develop. For large projects that may require months of development time, however, a more structured format is necessary to maintain the project focus. The more formal approach has been used on such projects as the 15 000-ha Redwood Creek restoration program in California (Belous 1984) and the watershed rehab plan for a 5000-ha management unit at Stewardson Inlet, B.C.[1]

The time required to develop a soil erosion and sediment control plan depends on the project scale, complexity of the management concerns, and the number of problem sites. As such, total watershed area alone should not determine plan budgeting. As in most planning exercises, accuracy in the costing process depends on the background information available.

Regardless of the project scale, however, a soil erosion and sediment control plan generally includes five major components:

1. definition of objectives;
2. inventory of active and potential problems;
3. ranking of problem sites;
4. treatment options; and
5. cost and scheduling.

The plan objectives and information gathered in the area inventory are used to assign a priority to each specific problem site. The specialist then uses these priorities to select appropriate treatment options and make operational specifications. In general, the more sophisticated (and usually more expensive) methods can only be justified on the higher priority sites. All these components, plus other factors such as access and season, contribute to the eventual project budget and scheduling. Where the available funding for the program is limited, the priority assignment and general costing data can guide the final selection of sites to be treated.

3 PLAN COMPONENTS

3.1 Rehabilitation Objectives

Various resource agencies and public groups participate with the forest manager in this first component of the project. Both timber and non-timber resources must be considered in defining the objectives of the soil erosion and sediment control plan. Some of the factors taken into account are:

- forest development and management plans;
- fish habitat protection;
- water quality concerns;
- potential slope stability and mass wasting;

[1] Carr, W.W. and I. Wright. 1987. Unpublished data.

- integrity and capability of drainage structures;
- long-term road maintenance planning;
- visual impact and aesthetics; and
- recreational use.

Erosion prevention, amelioration, mitigation, and rehabilitation objectives for the project area must be clearly stated and ranked in overall importance. These objectives are not only important to effective integrated resource management, but they also play an important role in the latter sections of the rehab plan.

3.1.1 Objectives of the Shomar Creek plan

Fletcher Challenge plans to continue forestry operations in the Shomar drainage in accordance with the overall management plans for TFL 42. These operations include road building, timber harvesting, and stand tending. Recognizing the potential effect of such activities on slope stability and downstream fishery values, the Sandspit Division has adopted a soil erosion and sediment control plan. The objectives of the plan are:

- to address active and potential soil erosion and sediment problems associated with existing forest development through repair, upgrading, and rehabilitation; and
- to plan and implement future forestry operations so as to prevent or minimize potential negative impacts.

Logging-related and road-initiated erosion and sediment problems are present in this watershed. These problems will be treated in the manner prescribed in the plan as funding becomes available. As well, future forest development plans in this area will consider the information gathered in the inventory on the cause and location of problem sites. This additional information, when combined with high operational standards and an aggressive mitigation program, should minimize the potential impacts of road-building and timber-harvesting operations on other resource values.

3.2 Erosion Inventory

The second component of the plan is an inventory of problem sites within the watershed or area of concern. The inventory is conducted with the use of air photographs and on-site inspections. Active erosion sites and sediment delivery routes are identified on air photographs (preferably recent colour photos at 1:10 000 scale), classified as to origin or cause, measured and catalogued. Potential erosion and slope stability problems are also included in the inventory.

To facilitate the on-site verification of the air photo inventory, as well as to update recent erosion activity, all problem sites are located (at scale) on available area maps. These maps, preferably at a scale of 1:5000 or 1:2500, should also include pertinent area information such as logging history, future development plans, soil and terrain type, fishery and other resource values. During the on-site inspection, the accuracy of air photo identification should be validated and evidence of recent erosion activity noted. Information required for assigning priorities (see Section 3.3) should also be gathered. This inspection gives the sediment and erosion control specialist an opportunity to begin formulating rehab or treatment options.

3.2.1 Shomar Creek inventory of problem sites

The disturbance inventory of erosion sites was initially conducted using 1987 colour air photographs (1:10 000). The inventory first had to be updated, however, with an extensive, on-site inspection of the entire watershed. Recent road development and timber harvesting activity (1987–88) in the Spur 104 system had created numerous new erosion sites. Most of these were associated with logging in a V-notch gully complex. The older Spur 105 system also needed ground inspection so that potential road-related problems obscured in the photos by second-growth regeneration could be identified.

The disturbance inventory is summarized in a format like that shown in Table 1, and all sites are located on the accompanying 1:5000 rehab mylar (Figure 2: a portion of the operational mylar). Each problem site is categorized as to its origin or cause (type), and additional information is given in the other columns. Although the categories selected for this project may be simplistic compared to those in some slope stability inventory systems, they convey enough information to direct the rehab program. The category selection and definitions are flexible and may be modified in future rehab plans to parallel other surveys as long as the needs of the rehab program are met.

Road-associated problems (R) include major cut and fill/sidecast slopes, as well as road-initiated mass wasting. The slide category (S) implies open slope failures that are generally related to yarding damage. Gully failure (G) applies to debris torrent/avalanche activity in steep-sided, V-notch gullies. Debris-torrented stream channels (Str) were separated from the gully category to denote extensive in-channel scouring. The configuration (size) and area of each problem site is also included, along with relevant comments.

TABLE 1. Shomar Creek disturbance inventory[a]

I.D. no.	Type of failure[b]	Size (m)	Area (ha)	Comments
34	S	25x70	0.18	Incipient failure
35	R	Spot-size		Seepage site, chronic maintenance problem
36	G/S	15x300	0.45	Above Spur 104D2A
37	G	10x350	0.35	Below Spur 104D2A
38	R	10x25	0.025	Associated with rock pit
39	R	10x10	0.01	Seepage site

[a] This example is drawn from Table A1 in the Appendix.
[b] S–slide; R–road; G–gully.

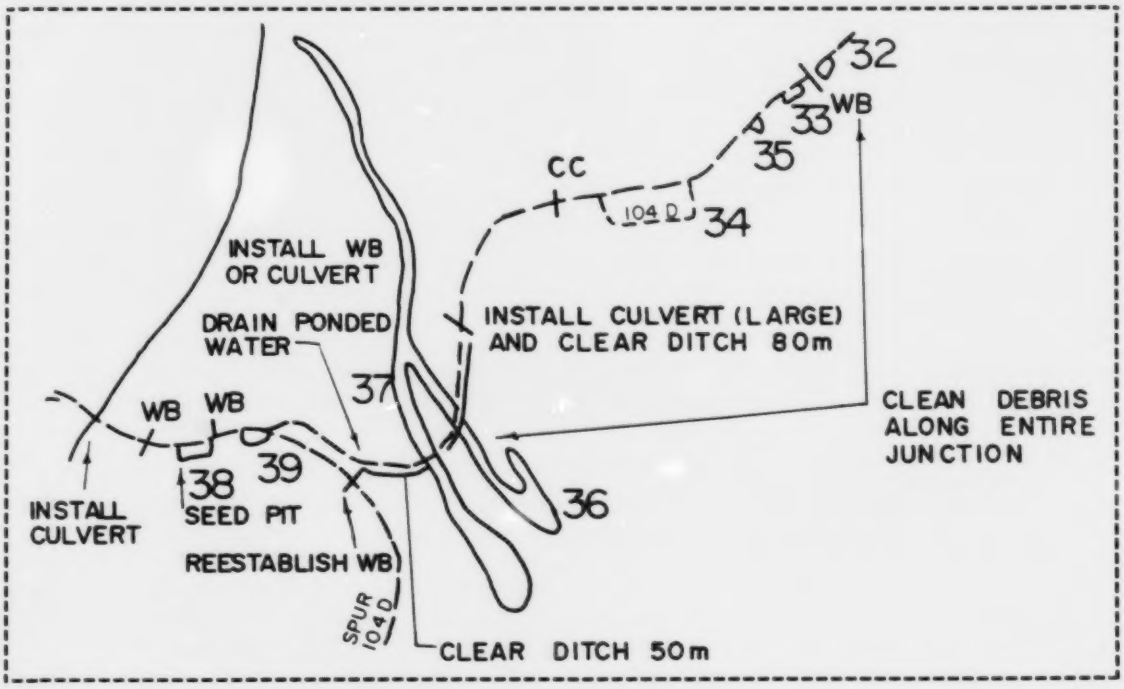

FIGURE 2. Example from the Shomar Creek rehab mylar.

3.3 Priority Assignment

Once the first two components are completed, it now becomes possible to establish criteria for prioritizing steps in the implementation of the rehab plan. The criteria must not only reflect the overall plan objectives, but they must also address such factors as the immediacy and magnitude of potential impact. These latter concerns can be inferred from the inventory data. The soil erosion and sediment control specialist has the primary responsibility in developing this component.

Although an experienced specialist may intuitively assign priorities, such decisions are usually based on an individually developed expert system. The three-step expert system that guided decisions made in the Shomar Creek study is presented in Figure 3.

Step 1: Determine the stage of erosion

Stage	Priority
Early/prevention	Very high
Active	See Step 2
Advanced/stable	Very low

Step 2: Determine active erosion priority (AEP)

2a. Assess potential erosion magnitude (PEM)
PEM = f(erosion hazard, size of area)
Erosion hazard (VH,H,M) based on Carr *et al.* (1991)
Size: Large (L) - ≥0.2 ha
Small (S) - <0.2 ha

Erosion hazard	and	Size	yield	PEM rating:
VH		L		6
VH		S		5
H		L		4
H		S		3
M		L		2
M		S		1

2b. Assess sediment delivery potential (SDP)
SDP = f(sediment entry route, distance)
Route: Direct (D), Indirect (I), Nil (N)
Distance: Long (L) - ≥100 m
Short (S) - <100 m

Route	and	Distance	yield	SDP rating:
D		S		3
D		L		2
I		S or L		1
N		S or L		0

2c. PEM + SDP = AEP

Total 7–9 High
4–6 Medium
1–3 Low

Step 3: Conditional modifiers

3a. Inaccessible – reduce class
3b. Potential trigger mechanism – raise class
3c. Sensitive watershed resource – raise class

FIGURE 3. System for assigning priority classes in the Shomar Creek study area.

The first step in this expert system (Step 1) addressed the stage of the erosion process. In general, control of early stage erosion (or prevention) was immediately classified as a very high priority. Such sites commonly require action to control surface water flow before soil erosion accelerates. Prevention and the control of early stage erosion are by far the most cost-effective approaches to watershed protection. Those sites that are in an advanced stage of erosion, having begun natural recovery through vegetation recolonization, are considered very low priority. Such sites have very limited potential for continued sediment delivery and usually require no treatment. It is the actively eroding areas addressed in Step 2 that present the most difficult problem in assigning priorities.

In determining the priority assignment for actively eroding areas ("active erosion priority" or AEP), both the magnitude of the erosion/sediment problem and the immediacy of the impact must be considered. The potential erosion magnitude (PEM) is a function of erosion hazard and size (Step 2a). To determine erosion hazard, a standard key such as that presented in Carr *et al.* (1991) may be used. For the Shomar study area, the erosion hazard ranged from medium to very high. This basic hazard is then combined with a size classification to yield a PEM. In the Shomar study, 0.2 ha was chosen as the boundary for large versus small sites. The resulting PEM rating ranges from 1 to 6.

In the second part of Step 2 (2b), a rating for sediment delivery potential (SDP) is developed to gauge the immediacy of potential impact on watershed resources. The SDP is a function of sediment entry route (direct, indirect, or nil) and the distance to a particular resource of concern. For the Shomar study, a SDP rating from 0 to 3 was created. The sum of the potential erosion magnitude (PEM) and the sediment delivery potential (SDP) in Step 2c yields the active erosion priority (AEP), which for this study area ranged from low to high.

An important final step in assigning priorities to problem sites (Step 3) provides scope for professional judgement. Specific conditional modifiers, specifically developed for each area, can be superimposed on the priority process. These may either raise or lower a previous priority level. Access (3a) is often an overriding factor to operational rehabilitation, and as such may limit treatment options to less effective methods or total deferment. Risk factors (3b and 3c) can also be included. Areas that appear relatively stable but have the potential to trigger other erosion problems (3b), such as small sidecast slopes with tension cracks, may be raised in treatment priority to that of prevention. It is also possible to include factors that further address specific plan objectives (3c). A site with a medium AEP may be moved into a higher category if a very high value resource, such as fish habitat or water quality, is at jeopardy.

3.3.1 Priority criteria for Shomar Creek

The assignment of priorities to identified problem sites in the Shomar Creek watershed was based on the magnitude and immediacy of the potential effects on the road network, slope stability, and water quality. The priority qualifications are:

- Very high – designated for those sites that are associated with road maintenance or repair; primarily concerned with surface water management.
- High – designated for those sites that currently affect water quality, slope stability, or the transportation network.
- Medium – designated for those sites that have a moderate impact on water quality, slope stability, or the transportation network; includes sites that have potential for expansion or reactivation.
- Low – designated for those sites where impact is minimal.
- Very low – designated for those sites that are no longer eroding; includes sites that have been recolonized with natural vegetation.

The priority assignment is usually presented in a rehab treatment and priority table (Table 2: a sample portion of Table A2 from the operation plan). A substantial amount of very high priority road rehabilitation (maintenance and repair) is required in the Shomar Creek area. These activities, being very site-specific, are presented on the rehab mylar (see Figure 2: inventory example) but not in the tables. These locations were also flagged in the field during the watershed inspection.

TABLE 2. Shomar Creek rehab and priority summary[a]

I.D. no.	Area (ha)	Rehab options[b]	Priority	Comments
34	0.18	None	Very low	Failure likely
35	Spot-size	Maintenance	High	Chronic problem
36	0.45	H.S. (Heli), B.S.S	High	
37	0.35	H.S. (Heli)	High	
38	0.025	D.S.	Low	
39	0.01	Clean ditch	Very high	

[a] This example is drawn from Table A2 in the Appendix.
[b] H.S. (Heli) – hydroseeding using helicopter bucket; B.S.S. – biotechnical slope stabilization using Sitka spruce and shrubs. D.S. – dry seeding by hand.

3.4 Treatment Options

The sediment and erosion control specialist has a wide range of methods and techniques with which to develop a rehab plan. These methods are usually divided into four general categories:

1. prevention;
2. temporary sediment and erosion control;
3. permanent sediment and erosion control; and
4. biotechnical slope stabilization.

Each method has certain soil, climate, and seasonal requirements, response time and effectiveness, and associated costs. These factors must be evaluated in relation to the management objectives and priority assignment before a rehab treatment or combination of treatments is selected for a specific problem site.

The goal of prevention is to keep the conditions for accelerated soil erosion and mass wasting from occurring. Within an actively managed watershed, this is usually achieved through the management of water flow patterns to prevent undesirable diversions or blockages. Included among the preventative treatments are enhancement of road drainage through increased culvert capacity (size and number), improved ditch maintenance and construction, proper long-term road maintenance using waterbars and cross-drains, and removal of slash and debris deposits from natural drainage courses. Many of these prevention treatments are recommended standard procedures in road building and timber harvesting. However, potential problem areas that may have been overlooked or not expected should be identified during the inventory process.

The goal of temporary sediment and erosion control techniques is to control surface erosion and sediment production until permanent erosion control systems are in place. These measures are often used immediately after soil disturbance when the erosion and sediment potential are greatest. Sediment trapping systems such as silt fences, straw bale barriers, and settling ponds are often used to protect water quality. Establishment of ground cover using rapidly growing but short-lived cover crops or biodegradable mulches is also an option. These temporary measures are usually assigned to active, high priority sites.

The more permanent rehab treatments provide long-term sediment and erosion control by creating a low maintenance system that:

- dissipates excessive erosive energies;
- increases resistance to particle detachment; and
- controls sediment transport.

The establishment of a vigorous, self-sustaining grass/legume ground cover is the primary objective of these techniques. Aside from providing highly effective and cost-efficient surface erosion control, grass-legume

establishment has a secondary benefit of accelerating the recolonization of native vegetation (the "natural" healing process). The method of cover establishment, either dry seeding or hydroseeding, depends on slope steepness, erosion potential, and site priority. Access is often the deciding factor between ground or helicopter application. Erosion control revegetation mats can be used either to augment or to replace vegetation establishment should the priority assignment warrant the extra cost. Permanent and temporary sediment and erosion control methods are discussed in detail in Carr (1980 and 1985).

The fourth category of rehabilitation methods, biotechnical slope stabilization, refers to the use of woody vegetation to increase slope stability against shallow mass wasting events such as soil flow or rotational slumps. Often combined with engineering structures, biotechnical slope stabilization encourages the establishment of a dense root network to enhance soil shear strength. The variety of techniques available are discussed at length in Gray and Leiser (1982) and Schiechtl (1980). These systems may be very simple to extremely complex in design, depending on specific site requirements. Experienced personnel are needed to plan and implement the more complex systems.

3.4.1 Recommended treatments for Shomar Creek

The rehabilitation methods recommended for use in the Shomar Creek study are:

D.S. – dry seeding by hand

D.S. (Heli) – dry seeding using helicopter bucket

H.S. – hydroseeding by truck

H.S. (Heli) – hydroseeding using helicopter bucket

B.S.S. – biotechnical slope stabilization using Sitka spruce and shrubs

D.C.C. – drainage course clearing

The recommended treatment option for each problem site is presented in the rehab and priority table (Table 2). The treatment may consist of a single operation or a combination of techniques. The combination treatment, generally including hydroseeding and biotechnical slope stabilization, is designed to control surface erosion and enhance slope stability. This treatment, usually assigned to areas that have been subjected to major site disturbance, has been successfully used for landslide rehabilitation in other areas of the Queen Charlotte Islands. The sequence of implementation in the combination treatments is implied by the order in which they are listed. Detailed descriptions and specifications for each rehabilitation option are presented in Section A5.2 of the operational plan included in Appendix 1.

In addition to the treatments presented in the rehab and priority table, a number of site-specific road rehabilitation activities are noted directly on the master rehab mylar. These activities include 63 waterbar installations, 2 cross-drains (or impassible waterbars), 3 fords (wide, shallow waterbars), over 400 m of ditch establishment, and general ditch and culvert maintenance.

3.5 Costs and Scheduling

The last component, costs and scheduling, begins as the implementation of the plan approaches. In the initial planning stages, only limited data are available for approximating the eventual costs and schedule of the operational rehabilitation.

Devising a budget is difficult in the early phase of a rehab project because there are several complicating factors. Some treatment options, especially those deemed as preventative, are often operations routinely undertaken by the forest licensee or management agency. In such cases, "in-house" costs can be applied once minor adjustments have been made to include extra mobilization to the treatment area. For those options requiring special contractor services, particularly the revegetation options, direct negotiations are necessary. Such factors as the scale of operation, the logistics of mobilization and site access, and the availability of support services can dramatically influence "outside" contractor costs. Because of all the operational variables that enter the costing process, the initial plan should treat costs in a general way. The budget will become more definitive as the field operations are confirmed.

The scheduling aspect of this component depends on access and equipment/contractor availability, as well as on the anticipated environmental conditions. Many of the revegetation treatment options have specific moisture and temperature requirements which cannot be ignored. As such, some flexibility in scheduling must be maintained to insure optimum conditions at the time of operation. An additional consideration in scheduling is the sequence of treatment installations where multiple treatments are prescribed, and the downslope implications, if there are any. The proper order of installation is mandatory to prevent detrimental impacts of one treatment on another.

3.5.1 Scheduling and costing for Shomar Creek

Access is the overriding concern in implementing this soil erosion and sediment control plan. The entire Spur 105 system is inaccessible because of two bridge washouts, and the back portion of Spur 104 (104F, G, and H) is blocked by road failure. All rehab activity in these areas must be deferred until these problems are corrected.

The accessible portion of the Spur 104 network, 104A through 104E, includes the more recently logged portion of the watershed and most of the actively eroding sites. The road network has extensive cut banks, considerable grade, and numerous drainage problem. Many of the very high and high priority problem sites in the Shomar Creek watershed are in this area. All recommended road rehabilitation activities, primarily directed at prevention, should be undertaken immediately. Failure to do so will result in new road-initiated mass wasting.

Fletcher Challenge has already begun rehabilitating several gully failures associated with 1987–88 logging. This rehabilitation includes dry seeding and limited spruce planting. The results are encouraging, but should be augmented by full implementation of recommended landslide rehabilitation procedures.

The rehabilitation of many very high, high, and medium priority sites in this accessible area (Spur 104A–E) was initiated in April 1989. The following work, in approximate quantities, was done:

waterbars	25 installed
culverts	3 installed
ditch establishment and maintenance	750 m
dry seeding	1.15 ha

The road maintenance and rehabilitation treatments were an extension of standard Fletcher Challenge programs. Future activities, such as hydroseeding treatments, however, will require the services of an erosion control contractor.

Contractor costs for hydroseeding are usually based on mobilization expenses, equipment and material requirements, and support services (i.e., helicopters, barging, etc.). Approximate costs for the hydroseeding treatments as specified in Section A5.2 of the operational plan (exclusive of mobilization and helicopter rental) were approximately:

Standard truck hydroseeding	
Materials	$1300
Equipment and labour	1300
	$2600/ha
Helicopter hydroseeding	
Materials	$1300
Equipment and labour	900
	$2200/ha

Helicopter requirements were approximately 1.5–2.0 hr/ha for operation in the Shomar area. While mobilization to the Queen Charlotte Islands can be relatively expensive, this cost component (on a per-hectare basis) could be reduced in future operations if several other projects were also undertaken at the same time.

4 SUMMARY

The implementation of soil erosion and sediment control procedures in managed forest watersheds can alleviate, and sometimes even prevent, the potential negative impact of harvesting development on watershed values. Use of these procedures should be an integral part of forest land management. Proper watershed rehabilitation is important to the success of a cost-efficient soil conservation program.

The planning process presented in this report shows the basic structure that all such systems for rehab operations should follow. However, the structure is flexible to address specific watershed concerns. The appendix of this report contains the entire operational soil erosion and sediment control plan for the Shomar Creek drainage in the Queen Charlotte Islands. Fletcher Challenge's implementation of this plan will, it is hoped, serve as a stimulus for other forest operators to adopt such an aggressive, positive approach to sediment and erosion control.

APPENDIX 1. Soil erosion and sediment control plan: Shomar Creek, Queen Charlotte Islands, TFL 42, Fletcher Challenge Ltd.

TABLE OF CONTENTS

A1 INTRODUCTION 14

A2 OBJECTIVES 15

A3 INVENTORY OF ACTIVE AND POTENTIAL PROBLEM SITES 15

A4 PRIORITY ASSIGNMENT 15

A5 REHABILITATION TREATMENTS AND SPECIFICATIONS 18

A5.1 Options 18
A5.2 Detailed Rehabilitation Prescription Specifications 18

A6 SCHEDULING AND COSTS 21

A7 CONCLUSION 22

TABLES

A1 Shomar Creek disturbance inventory 16

A2 Shomar Creek rehab and priority summary 17

FIGURES

A1 Location of Shomar Creek study area 14

ENCLOSURE

Shomar Creek: 1:5000 Rehab mylar

A1 INTRODUCTION

The Shomar Creek watershed is centrally located along the northern edge of Moresby Island, part of the Queen Charlotte Islands (Figure A1). The creek enters the Deena River, a major salmon spawning and rearing river, approximately 6 km from the South Bay estuary. Shomar Creek is a class IV stream with no fish population because of a major blockage at the old Spur 105 crossing. However, the creek is important to downstream fish habitat because of its relatively high flow capacity and substantial sediment delivery potential.

Encompassing approximately 900 ha of good and medium site forest land, the Shomar Creek watershed is an important area in TFL 42. As part of the Coastal Western Hemlock – wet hypermaritime (CWH–wh1) biogeoclimatic zone, its old-growth stands are composed of western redcedar, western hemlock, and Sitka spruce. Second-growth stands are predominantly Sitka spruce and western hemlock. This steep-sided drainage basin is a complex of terrain units. The lower portions of the watershed are mainly glaciofluvial and morainal materials; the middle and upper slopes are dominated by morainal blankets or colluvial veneer and exhibit substantial bedrock influence. Often exceeding 100% in steepness, the upper slopes are characterized by steep, unstable gully systems.

Harvesting activity began in the watershed during the mid-1960's, with initial operations concentrated on the flatter areas and the west side of the basin accessed by the Spur 105 road network. The more recent and current logging activities are on the east slopes and along the Spur 104 system. Future plans include continued old-growth logging and the reopening of the Spur 105 road complex for stand management access.

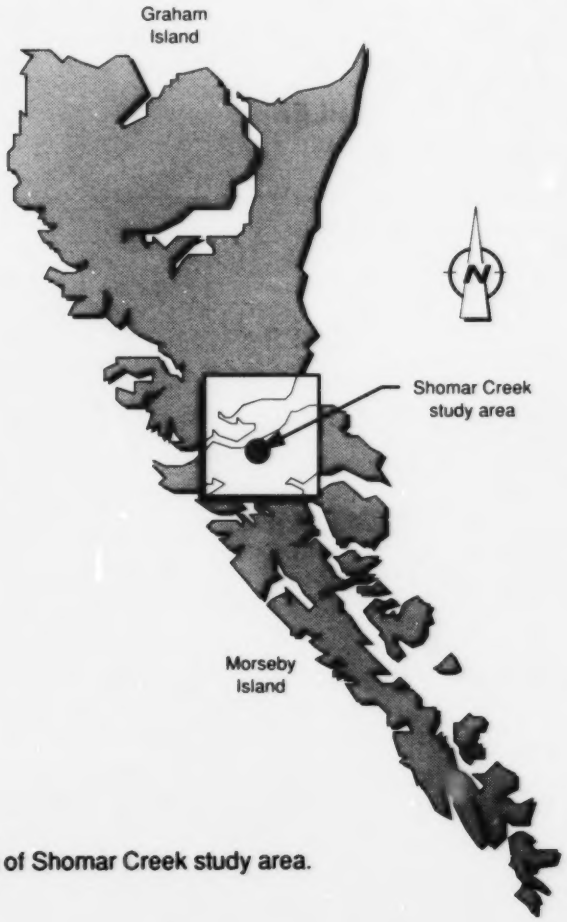

FIGURE A1. Location of Shomar Creek study area.

A2 OBJECTIVES

Fletcher Challenge plans to continue forestry operations in the Shomar drainage in accordance with the overall management plans for TFL 42. These operations include road building, timber harvesting, and stand management. Recognizing the potential negative effect of such activities on slope stability and downstream fishery values, the Sandspit Division has adopted a soil erosion and sediment control plan for the Shomar Creek watershed. The major objectives of this plan are:

- to address active and potential soil erosion and sediment problems through repair, upgrading, and rehabilitation; and
- to plan and implement future forestry operations so as to prevent or minimize potential negative impacts.

Logging-related and road-initiated erosion and sediment problems are present in this watershed. These problems will be treated in the manner prescribed in the plan as funding becomes available. As well, future forest development plans in this area will consider the information gathered in the inventory on the cause and location of problems sites. This additional information, when combined with high operational standards and an aggressive mitigation program, should minimize the potential impacts of road-building and timber-harvesting operations on other resource values.

A3 INVENTORY OF ACTIVE AND POTENTIAL PROBLEM SITES

The disturbance inventory of erosion sites was initially conducted using 1987 colour air photographs (1:10 000). The inventory first had to be updated, however, with an extensive, on-site inspection of the entire watershed. Recent road development and timber harvesting activity (1987–88) in the Spur 104 system had created numerous new erosion sites. Most of these were associated with logging in a V-notch gully complex. The older Spur 105 system also needed ground inspection so that potential road-related problems obscured in the photos by second-growth regeneration could be identified.

The disturbance inventory is summarized in Table A1, and all sites are located on the accompanying 1:5000 rehab mylar (Enclosure 1). Each problem site is categorized as to its origin or cause (type), and additional information is given in the other columns. Although the categories selected for this project may be simplistic compared to those in some slope stability inventory systems, they convey enough information to direct the rehab program. The category selection and definitions are flexible and may be modified in future rehab plans to parallel other surveys as long as the needs of the rehab program are met.

Road-associated problems (R) include major cut and fill/sidecast slopes, as well as road-initiated mass wasting. The slide category (S) implies open slope failures that are generally related to yarding damage. Gully failure (G) applies to debris torrent/avalanche activity in steep-sided, V-notch gullies. Debris-torrented stream channels (Str) are separated from the gully category to denote extensive in-channel scouring. The shape and area of each problem site is also included, along with comments.

A4 PRIORITY ASSIGNMENT

The assignment of priorities to the identified problem sites (Table A2, column 4) was based on the magnitude and immediacy of the potential effects on the road network, slope stability, and water quality. The qualifications for the priority classes are:

Very high – designated for those sites that are associated with road maintenance or repair; primarily concerned with surface water management.

High – designated for those sites that currently affect water quality, slope stability, or the transportation network.

Medium – designated for those sites that have a moderate impact on water quality, slope stability, or the transportation network; includes sites that have potential for expansion or reactivation.

TABLE A1. Shomar Creek disturbance inventory

I.D. no.	Type of failure[a]	Size (m)	Area (ha)	Comments
1	R	15x15	0.02	Overloaded sidecast; imminent failure into slide complex No. 3
2	R	15x20	0.03	Debris-loaded road/drainage crossing, high movement potential above slide complex No. 3
3	S	80x220	1.76	Active slide complex intercepts creek; natural alder revegetation
4	S	25x100	0.25	Old slide; colonized with alder
5	S	20x20	0.04	Creek bank failure
6	S	20x100	0.20	Probably windthrow initiated
7	R	30x160	0.48	Sidecast failure; active
8	R	Spot-size		Cut bank failure with large stump
9	R	10x10	0.01	Washout
10	G/Str	15x300	0.45	Gully failure and debris-torrented stream
11	G/Str	15x150	0.23	As above
12	S	10x120	0.12	Reactivated old slide
13	S	30x50	0.15	Probably windthrow initiated gully failure
14	G	15x150	0.23	
15	R	40x250	1.00	Potential secondary failure
16	R/S	100x300	3.00	Potential secondary failure
17	S	15x130	0.20	Natural recovery
18	S	30x130	0.39	Reactivated slide; intercepts stream channel
19	Str	40x200	0.80	Debris-torrented stream
20	G	10x70	0.07	Probable yarding damage; slump on road blocks access; stabilizing naturally
21	R/G	10x120	0.12	Large slump on road blocks access; stabilizing naturally; probably intercepted stream channel
22	R	10x20	0.02	Small slump intercepted by road surface; prohibits access
23	R	15x50	0.08	Large slump intercepted by road
24	Str	25x100	0.25	Debris and sediment fan above old bridge washout
25	G	10x100	0.10	Old slide naturally colonized with alder
26	Str	50x200	1.00	Sediment fan upstream of old bridge site and large debris dam
27	R	20x20	0.04	Slump on road surface blocks access; perched above gully
28	R	30x100	0.30	Overloaded sidecast failure
29	R	10x10	0.01	Debris-loaded gully
30	G	30x300	0.90	Previously hand seeded
31	G	20x350	0.70	Previously hand seeded
32	R	4x10	0.004	Seepage site above No. 31
33	R	5x5	0.0025	Seepage site above No. 31
34	S	25x70	0.18	Incipient failure
35	R	Spot-size		Seepage site, chronic maintenance problem
36	G/S	15x300	0.45	Above Spur 104D2A
37	G	10x350	0.35	Below Spur 104D2A
38	R	10x25	0.025	Associated with rock pit
39	R	10x10	0.01	Seepage site
40	R	25x50	0.13	Overloaded sidecast failure; could reactivate No. 41
41	G	15x30	0.05	Naturally revegetated
42	R	8x50	0.04	
43	R	Spot-size		Overhanging stumps
44	R/G	20x100	0.20	
45	G	10x70	0.07	
46	G	25x100	0.25	Heavy debris loading in gullies; monitor stability
47	Str	10x100	0.10	Debris-torrented stream
48	R	5x300	0.15	Drainage problems with Spur 104C
49	G/S	25x100 avg. for 10 areas	2.5	Slide complex

[a] R – road; S – slide; G – gully; Str – stream.

TABLE A2. Shomar Creek rehab and priority summary

I.D. no.	Area (ha)	Rehab options[a]	Priority	Comments
1	0.02	Excavate overloaded sidecast, D.S.	Very high	Imminent failure above existing active slide complex
2	0.03	D.C.C.	Very high	Unload debris loading at road crossing
3	1.76	D.S. (Heli)	High	
4	0.25	D.S. (Heli)	High	
5	0.04	None	Very low	
6	0.20	D.S. (Heli)	Medium	
7	0.48	D.S.	Medium	Concentrate on 30 x 50 m area below sidecast
8	Spot-size	D.C.C.	Very High	Remove stump above road cut; failure imminent
9	0.01	Road repair	Medium	Use large rock to stabilize road edge
10	0.45	D.S., B.S.S., D.C.C.	Medium	Sediment fan appears stable, open road
11	0.23	D.S., B.S.S., D.C.C.	Medium	As above
12	0.12	D.S. (Heli)	Low	
13	0.15	D.S. (Heli)	Low	
14	0.23	D.S. (Heli)	Low	
15	1.00	D.S. (Heli), D.C.C.	Very high	Seed slide, open road
16	3.0	D.S. (Heli), B.S.S.	High	Deposits into No. 19
17	0.20	None	Very low	
18	0.39	D.S. (Heli), B.S.S.	High	Deposits into No. 19
19	0.80	D.S. (Heli), B.S.S	High	
20	0.07	None	Very low	
21	0.12	None	Very low	
22	0.02	D.S., B.S.S.	Low	
23	0.08	D.S., B.S.S.	Low	
24	0.25	None	Very low	
25	0.10	None	Very low	
26	1.0	None	Very low	
27	0.04	Monitor	Medium	Potential for triggering slide into gully; no rehabilitation recommended at this time
28	0.30	D.S. (Heli)	Low	
29	0.01	D.C.C.	Very high	Unload debris at pulled gully crossing
30	0.90	H.S. (Heli), B.S.S	High	Intercepted by flat valley bottom
31	0.70	H.S. (Heli), B.S.S.	High	
32	0.004	B.S.S.	High	Above No. 31
33	0.0025	B.S.S.	High	Above No. 31
34	0.18	None	Very low	Failure likely
35	Spot-size	Maintenance	High	Chronic problem
36	0.45	H.S. (Heli), B.S.S.	High	
37	0.35	H.S. (Heli)	High	
38	0.025	D.S.	Low	
39	0.01	Clean ditch	Very high	
40	0.13	H.S., B.S.S. Excavate overloaded material	Very high	Could reactivate No. 41
41	0.04	None	Very low	Stable
42	0.04	H.S., B.S.S.	High	Sediment source
43	Spot-size	B.S.S.	Medium	
44	0.20	H.S., B.S.S.	High	Sediment source
45	0.07	D.S., B.S.S.	Low	
46	0.25	D.S., monitor	Low	Seed-bare soil patches
47	0.10	B.S.S.	High	Sediment source; install shrubs on unconsolidated banks
48	0.15	H.S.	Medium	Seed ditch to minimize downcutting
49	2.50	D.S., B.S.S.	Low	Potential significant loss of growing site

[a] H.S. (Heli) – Hydroseeding using helicopter bucket
B.S.S. – Biotechnical slope stabilization using Sitka spruce and shrubs
D.S. – Dry seeding by hand
D.C.C. – Drainage course clearing
D.S. (Heli) – Dry seeding using helicopter bucket
H.S. – Hydroseeding by truck

Low – designated for those sites where impact is minimal.

Very low – designated for those sites that are no longer eroding; includes sites that have been recolonized with natural vegetation.

A substantial amount of very high priority road rehabilitation (maintenance and repair) is required in the Shomar Creek area. These activities, being very site-specific, are presented on the rehab mylar, but not in the tables. These locations were also flagged in the field during the watershed inspection.

A5 REHABILITATION TREATMENTS AND SPECIFICATIONS

A5.1 Options

The recommended treatment option for each problem site is presented in Table A2 (column 3). The treatment may consist of a single operation or a combination of techniques. The combination treatment, generally including hydroseeding and biotechnical slope stabilization is designed to control surface erosion and enhance slope stability. This treatment, usually assigned to areas that have been subjected to major site disturbance, has been successfully used for landslide rehabilitation in other areas of the Queen Charlotte Islands. The sequence of implementation in the combination treatments is implied by the order in which they are listed.

The recommended rehabilitation treatments are:

D.S. – dry seeding by hand
D.S. (Heli) – dry seeding using helicopter bucket
H.S. – hydroseeding by truck
H.S. (Heli) – hydroseeding using helicopter bucket
B.S.S. – biotechnical slope stabilization using Sitka spruce and shrubs
D.C.C. – drainage course clearing

Detailed descriptions and specifications for the treatment options are presented in Section A5.2. In addition to these treatments, a number of site-specific road rehabilitation activities are noted directly on the master rehab mylar. These activities include 63 waterbar installations, 2 cross-drains (or impassable waterbars), 3 fords (wide, shallow waterbars), over 400 m of ditch establishment, and general ditch and culvert maintenance.

A5.2 Detailed Rehabilitation Prescription Specifications

A5.2.1 Dry seeding: helicopter or ground-based

Purpose:

- Dry broadcast application of seed and fertilizer is used to secure a grass-legume cover of at least 60%, and to accelerate the process of natural colonization.

Specifications:

- Seed and fertilizer is spread with a helicopter bucket or manually (with a belly grinder).
- The seed and fertilizer must be applied separately.
- The seeding rate is 40 kg/ha.
- The recommended seed mix, formulated for the climate and soil conditions at Shomar Creek, is:

Perennial ryegrass	20%
Creeping red fescue	25%
Timothy	10%
Redtop	5%
Alsike clover	20%
White clover	10%
Birdsfoot trefoil	10%

- Fertilizer recommendations should be based on soil analyses, although 250 kg/ha of high analysis fertilizer (20-24-15) will suffice for an initial application.
- Favourable moisture and temperature conditions are needed for 6–8 weeks after the seeding operation to obtain an adequate vegetative cover. If this is not possible, dormant seeding is recommended to take advantage of improved conditions in the next growing season. The generally recommended application periods for the Shomar Creek area are March 1 to June 15 for spring seeding and August 15 to September 30 for fall seeding.
- Refertilization and fill-in seeding are recommended within 2 years of initial operations to assure continued erosion control effectiveness.

Comments:

- Dry broadcast seeding is applicable to gentle slopes (less than 50%) and areas of low to medium erosion hazard. Success is best on newly constructed, roughened surfaces. This method, though relatively inexpensive, is not suitable for high erosion hazard areas.

A5.2.2 Hydroseeding: truck or helicopter

Purpose:

- Hydroseeding is the application to the soil of a seed and water slurry that may also contain fertilizer, a chemical tackifier, or a mulch. Its purpose is to secure a grass-legume ground cover of at least 60%, and to accelerate the process of natural colonization. Application can be made by a truck-mounted tank unit or by helicopter and bucket in conjunction with a truck-mounted tank unit for mixing the slurry.

Specifications:

- Seed, and other material, is spread on the area in a water slurry from a special mixing tank agitated at a constant rate.
- Although the seed and other material may be applied separately, they are generally mixed into a single slurry.
- The seeding rate is 80 kg/ha because of the high erosion hazard. The use of a cover/nurse crop, 20 kg/ha of fall rye, should also be considered.
- The recommended seed mix is the same as that presented in Section A5.2.1.
- Fertilizer recommendations should be based on soil analyses, although 350 kg/ha of high analysis fertilizer (20-24-15) will suffice for the initial application.
- A chemical tackifier, or soil binder, is almost always used with hydraulic seeding. The tackifier is usually an organic polymer that holds the seed and other material in place on the slope by forming a crust with the soil surface. Tackifier rates follow the manufacturers' recommendations, and usually range from 20–60 kg/ha depending on the slope steepness and erosion hazard.
- Hydromulch, consisting of a wood fibre base, is often used to enhance seed germination and increase soil resistance to erosive forces. A 500 kg/ha mulch application is often used to improve slurry cohesion. If soil temperature and moisture modifications are desired, an application rate of 1200–1500 kg/ha is recommended.
- Favourable moisture and temperature conditions are needed for 6–8 weeks after the seeding operation to obtain an adequate vegetative cover. If this is not possible, dormant seeding is recommended to take advantage of improved conditions in the next growing season.
- Refertilization and fill-in seeding are recommended within 2 years of initial operation to assure continued erosion control effectiveness. The recommended application periods for the Shomar Creek area are March 1 to June 15 for spring seeding and August 15 to September 30 for fall seeding.

Comments:

- Hydraulic seeding, although more expensive than dry seeding, is a proven technique for revegetating slopes greater than 2:1. Including tackifier and mulch increases the application costs, but can provide temporary erosion control for up to 6 months until the vegetation is fully established. Although most applications are from truck-mounted units, the technique has been adapted to specially modified buckets for helicopter application. This method has proven successful for use on inaccessible areas, such as landslides, on the Queen Charlotte Islands and Vancouver Island.

A5.2.3 Biotechnical slope stabilization

Purpose:

- Biotechnial slope stabilization (also known as bioengineering) is the use of vegetation, often in conjunction with engineering structures, to increase slope stability against shallow mass wasting events such as soil flow or rotational slumps.

Specifications:

- The vegetation increases soil shear strength by developing an extensive, reinforcing root network.
- Native, pioneer woody plants with an aggressive rooting habit are the preferred species. The generally recommended species for this technique are willow, cottonwood, and Sitka alder. However, past experience on the Queen Charlottes with deer browse problems indicates a combination of Sitka alder and spruce should be used in the Shomar Creek area.
- A high density grid planting, 1.5 x 1.5 m, of spruce and Sitka alder is recommended for problem sites in this project area. Linear planting systems such as brush layering have not been successful in other projects on the islands.
- Dormant season planting of tree and/or shrub stock is usually recommended for biotechnical slope stabilization projects. This may be modified for the Shomar Creek area, however, to coincide with normal reforestation practices.
- The Sitka alder seedlings required for the plantings are to be nursery grown from seed, not cuttings.
- For detailed explanations of various bioengineering systems, the following two texts are recommended:

  Bioengineering for Land Reclamation and Conservation, by Hugo Schiechtl. 1980. University of Alberta Press, Edmonton, Alta.

  Biotechnical Slope Protection and Erosion Control, by Donald H. Gray and Andrew T. Leiser. 1982. Van Nostrand Reinhold Co.. New York, N.Y.

Comments:

- Bioengineering systems can be simple or complex in design depending on specific site requirements. Specialized personnel will be needed for the more complicated designs. Project installation is usually labour-intensive, so projects can be expensive. However, bioengineering can be more cost effective than conventional engineering solutions when used wisely.

A5.2.4 Drainage course clearing

Purpose:

- Drainage course clearing is the clearing of accumulated logging and natural debris from a drainage course. The purpose is to enhance water quality or alleviate debris loading that can contribute to environmental damage from torrents triggered during periods of high runoff.

Specifications:

- Heavy clearing can be undertaken by machinery such as grapples or tractor type equipment that can winch out larger material.
- Hand clearing with a crew is normally the most expedient way of handling the debris to be cleared.
- Manpower requirements can vary according to the scale of the work undertaken. Two men with a backhoe would be required to clear a blocked gully crossing at a road, with up to six men plus a supervisor to clear debris from a channel.
- Tools used in hand clearing can be whatever is necessary to get the job done. Debris varies in size from large chunks or logs that require bucking into pieces that can be manhandled, to small branches that can be thrown out of the stream channel with a pitch fork. Typically, two to three chain saws and axes and several pitch forks would be employed by a six-man crew clearing a debris-loaded stream channel.
- The time required for clearing is site-specific and depends on many variables including accessibility, terrain, water depth, and quantity of debris.

Comments:

- Generalizations are difficult to make about drainage course clearing costs and work productivity. Projects are site-specific and, as such, manpower and cost estimates are best based on detailed site inspection or experience gained on site.

A5.2.5 Waterbar installation

Purpose:

- Waterbars provide an effective and inexpensive method of providing road drainage that is relatively maintenance free for inactive road systems which must be travelled periodically for land management purposes.

Specifications:

- Generally, a minimum of five to seven waterbars per kilometre would be needed for the coastal regions of British Columbia to handle drainage adequately on deactivated logging roads.
- Planning and mapping of waterbar locations by experienced personnel before their installation is essential for a cost-effective program.
- Small rubber-tired backhoes have proven to be very cost-efficient in waterbar installation.
- Detailed specifications for waterbars can be found in most forest road building texts.

Comments:

- Waterbar installation programs require the planning and mapping of installation locations. Proper project design is essential if land management objectives for access and road drainage requirements are to be cost effective.

A6 SCHEDULING AND COSTS

Access is the overriding concern in implementing this watershed rehab plan. The entire Spur 105 system is inaccessible because of two bridge washouts, and the back portion of Spur 104 (104F, G, and H) is blocked by road failure (site No. 9). All rehab activity in these areas, particularly high priority sites 1–4, 16, 18, and 19, must be deferred until these problems are corrected.

The accessible portion of the Spur 104 network, 104A through 104E, includes the areas recently logged and most actively eroding. Slopes are steep and gullied with a high degree of bedrock influence. The road network has extensive cut banks, considerable grade, and numerous drainage problems. Most of the high priority problem sites in the Shomar Creek watershed (sites 30, 31, 32, 33, 36, 37, 40, 42, and 44) are in this area.

Fletcher Challenge has already begun rehabilitating several gully failures associated with 1987–88 logging (Nos. 31, 36, and 37). The rehabilitation included dry seeding and limited spruce planting. The results are encouraging, but should be augmented by full implementation of recommended landslide rehabilitation procedures.

The rehabilitation of very high, high and medium priority sites in this accessible area was initiated in April 1989. Implementation of this portion of the rehab plan within the accessible portion of Spur 104 (104A–104E) has involved the following work:

waterbars	25
culverts	3
ditch establishment/maintenance	750 m
dry seeding	1.15 ha

The road maintenance and rehabilitation treatments were an extension of standard Fletcher Challenge programs.

The hydroseeding treatments, however, will require an erosion control contractor. Contractor costs for hydroseeding are usually based on mobilization expenses, equipment and material requirements, and support services (i.e., helicopters, barging, etc.). Costs for the hydroseeding treatments as specified, exclusive of mobilization and helicopter rental, are approximately:

Standard truck hydroseeding	
Materials	$1300
Equipment and labour	1300
	$2600/ha
Helicopter hydroseeding	
Materials	$1300
Equipment and labour	900
	$2200/ha

Helicopter requirements were approximately 1.5–2.0 hr/ha. While mobilization to the Queen Charlotte Islands can be relatively expensive, this component (on a per-hectare basis) could be reduced in future if several other projects were undertaken at the same time.

A7 CONCLUSION

The principal activities recommended in this rehab plan for the Shomar Creek watershed are directed at road maintenance and rehabilitation and landslide stabilization. The road-related operations are primarily preventative treatments that reduce the potential for mass wasting and facilitate future forest management access. The landslide stabilization treatments not only eliminate a major sediment source, but they may also accelerate the recovery of productivity on these degraded sites. As access is re-established in the watershed, problem sites will be further treated according to this soil erosion and sediment control plan. All future development should include a similar program — one which follows the same principles as those discussed in this plan.

LITERATURE CITED

Belous, R. 1984. Restoration among the redwoods. Restoration and Manage. Notes 2(2):57–64.

Carr, W.W. 1980. Handbook for forest roadside erosion control in B.C. Number 4. B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 4. 43 p.

———— . 1985. Watershed rehabilitation options for disturbed slopes on the Queen Charlotte Islands. B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 36. 35 p.

Carr, W.W., W.R. Mitchell, and W. Watt. 1991. Basic soil interpretation: soil compaction and surface erosion. B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 62. p.17.

Coastal Fishery Forestry Guidelines. 1987. B.C. Min. For., B.C. Min. Environ., Can. Dep. Fish. Oceans, and Council of Forest Industries. 11 p. + appendices.

Gray, D.H. and A. Leiser. 1982. Biotechnical slope protection and erosion control. Van Nostrand Reinhold Co., New York, N.Y. 271 p.

Schiechtl, H. 1980. Bioengineering for land reclamation and conservation. (Trans. by N.K. Horstmann). Univ. Alta. Press, Edmonton, Alta. 404 p.

MAPS
NOT
FILMED

CARTES
OMISES